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Views and opinions expressed by the authors of articles in this publication are their own, and they do not necessarily represent those of the publisher.

A mammoth hydroelectric development, sponsored by the Power Authority of the State of New York, is now under construction. The locale of the development, known locally as the Niagara Power Project, embraces the reach of the Niagara River between the cities of Niagara Falls and Lewiston, New York, and contiguous areas. The construction costs on the project are estimated to total $625 million.

Public bids for the building of the main power plant and appurtenances at Lewiston were received by the Authority on January 9, 1958. The low bid submitted was $98,288,498, by Merritt-Chapman & Scott Corporation of New York City. Subsequently the low bidder was awarded the contract.

The first work being done by the contractor involves the construction of access roads and preparations for the relocation of international transmission lines. Contracts for additional construction, equipment, and material will be awarded in May.

A review of some of the data and statistics involved in the Niagara Power Project begins on page 39.

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Pomme de Terre Dam, recently completed across the river near Hermitage, Missouri, is a threefold construction project of the U. S. Army's Corps of Engineers. Primarily designed for flood control, the dam will also control low-water flows and water supply, and will create one of the nation's important scenic recreational areas.

The dam is a composite rock- and earth-fill embankment that stretches 7,420 ft. across the valley. The reservoir which it will create will provide protection to 5,000 acres along the banks of the river.

The contractor, the George Bennett Construction Company of Kansas City, Kansas, handled the rock excavation by blasting the variable formations in 12-ft. benches. From 80 to 90 drill holes loaded with 1,000 lb. of explosives were fired in each primary blast. Results were excellent and a minimum of secondary blasting was required.

For more detailed information about this multipurpose dam in Missouri, please turn to page 43.

° ° °

The first hydroelectric development sponsored by the Government of Cuba is now under construction in Las Villas Province. Upon completion, the development, called the Hanabanilla Project, will supply low-cost electricity for Cuba's rapidly expanding industrial and domestic needs, and bring electric power to rural areas not supplied heretofore.

The construction details are being taken care of by Tecon Corporation of Dallas, Texas, under a contract with the Cuban government.

A summary of the activities on this new project in Cuba is given in the article starting on page 49.

° ° °

About 50 years ago Menke Stone and Lime Company abandoned certain workings in its underground mine at Quincy, Illinois, when the limestone deposit failed to meet the company's rigid specifications. The abandoned area, fed by numerous springs, eventually filled with water and became known as Hidden Lake.

Menke officials decided to seal the abandoned tunnels to prevent possible danger to anyone exploring the area. It was decided to use explosives to knock down supporting pillars. This blasting would cause the overburden to collapse and seal the mine.

For a description of how this unusual assignment was accomplished successfully with explosives, please turn to page 56.

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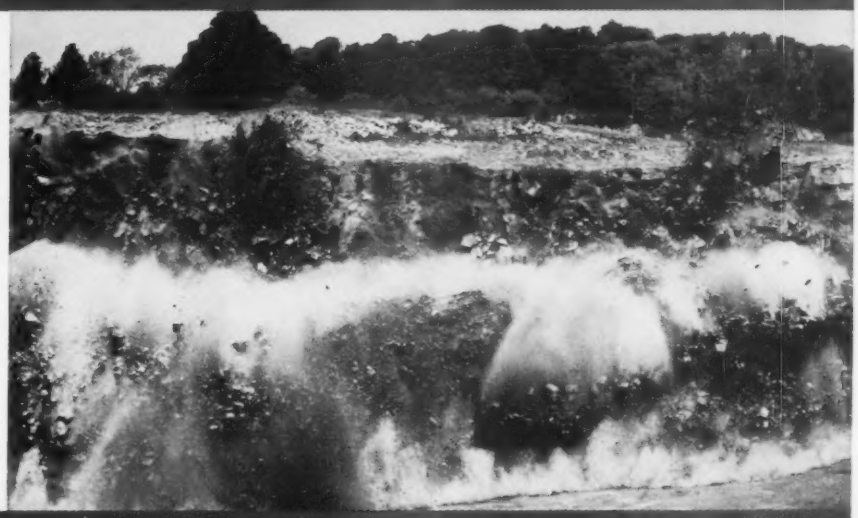

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Robert Holmes Hughes

PRESIDENT, CLINCHFIELD COAL COMPANY

VICE PRESIDENT, THE PITTSTON COMPANY

A Biography

ROBERT HOLMES HUGHES began his association with the coal industry at the age of twenty-four, as an engineer with Clinchfield Fuel Company. His sound training in the fundamentals, concentrated effort in a chosen field, plus unusual executive ability, brought about successive appointments to positions of responsibility in the Clinchfield organization. Today, as president of Clinchfield Coal Company and vice president of The Pittston Company, he is recognized as an outstanding leader in the business of mining and processing coal.

Bob, as his friends and associates know him, was born January 2, 1911, in Spartanburg, Spartanburg County, South Carolina, the son of Robert Holmes and Ada Eleanor (Bellotte) Hughes. After completing his elementary education in the local grade and high schools, he went to Clemson College, Clemson, South Carolina, and was graduated in 1932 with a B.S. degree in mechanical and electrical engineering.

Following his graduation from Clemson College, Bob went to work as a mechanical engineer with Fairforest Finishing Company, a textile firm in Spartanburg. After three years, he left the textile business to join the Engineering Department of Clinchfield Fuel Company of Spartanburg. In 1940, he was promoted to the position of assistant chief engineer of Clinchfield Coal Corporation at its headquarters in Dante, Virginia. He continued in that capacity, except for four years of service with the U. S. Army in World War II, until 1947, when he was promoted to chief engineer.

Bob's Army record includes more than three years of active duty in the European Theater of Operations – England, France, and Germany – as officer in charge of Signal Corps maintenance. He was awarded the Bronze Star for meritorious service. In 1946, he was released to inactive service with the rank of Lieutenant Colonel in the U. S. Army Signal Corps Reserve.

After four years as chief engineer of Clinchfield Coal Corporation, he was made vice president in charge of operations in 1951. One year later he was elected president of the corporation.

Bob continued as president of Clinchfield Coal Corporation until December 28, 1956, when it was merged with The Pittston Company. At that time he became vice president of The Pittston Company in charge of coal operations, and continued as the president of Clinchfield Coal Company, a division of The Pittston Company.

His other business affiliations include membership on the Boards of Directors of The Pittston Company; Bituminous Coal Operators Association; Bituminous Coal Research, Inc.; Virginia Manufacturers Association; and Dominion National Bank of Bristol, Tennessee. He is also a vice president of the Virginia Coal Operators Association and executive vice president of both Lillybrook Coal Company and Amigo Smokeless Coal Company.

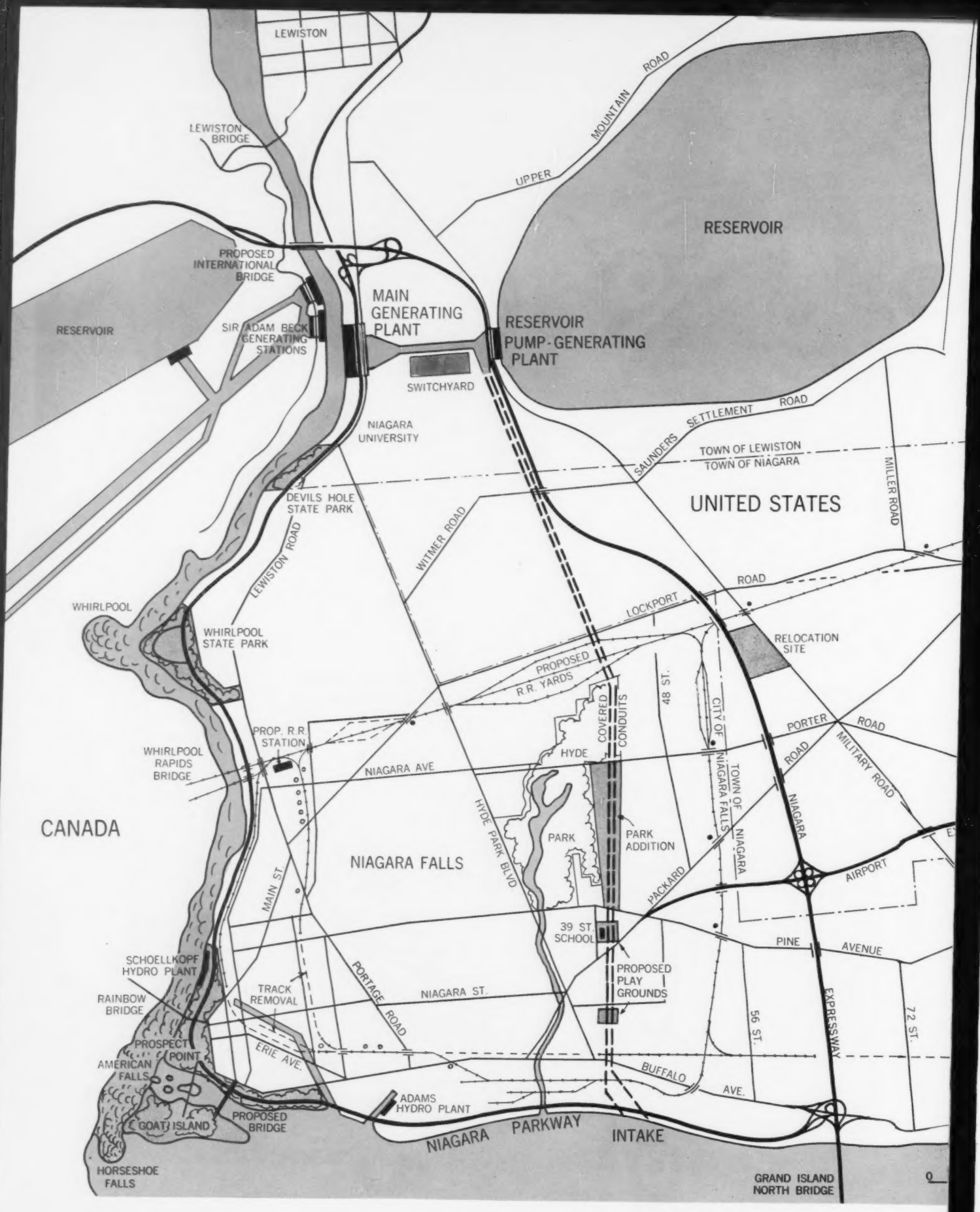
He is a member of the Governor's Advisory Council on the Virginia Economy and was a member of the American team of coal experts to Poland in July, 1957. The American Society of Mechanical Engineers honored him in 1954 with the presentation of its Richards Memorial Award for "outstanding achievement in mechanical engineering within twenty to twenty-five years after graduation."

He is a member of the American Institute of Mining, Metallurgical, and Petroleum Engineers; the American Society of Mechanical Engineers; and Tau Beta Pi. His club memberships include the Downtown in Richmond, the Shenandoah in Roanoke, and the Glenrochie Country in Abingdon, Virginia.

Robert Holmes Hughes married Joyce M. Kellett on February 11, 1933, in Spartanburg, South Carolina. They have one son, Robert Walter Anthony Hughes. The family home is at Gray Hill, St. Paul, Virginia.

Like many successful leaders in industry, Bob's principal hobby is his work. But, he manages to find time to unwind and relax from an unusually heavy schedule of responsibilities by "goin' fishin'" in nearby streams with his many friends and associates.

ROBERT HOLMES HUGHES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LEWISTON ROAD
ROAD
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WHIRLPOOL STATE PARK
LOCKPORT
RELOCATION SITE
PROPOSED R.R. YARDS
COVERED CONDUITS
48 ST.
CITY OF NIAGARA FALLS
PORTER ROAD
PROP. R.R. STATION
HYDE
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GOAT ISLAND
PROPOSED BRIDGE
NIAGARA PARKWAY
INTAKE
HORSESHOE FALLS
GRAND ISLAND NORTH BRIDGE

Niagara Power Project

Some data and statistics on the mammoth hydroelectric development now under construction along the river above Niagara Falls under the sponsorship of the Power Authority of the State of New York

THE Niagara Power Project is being constructed by the Power Authority of the State of New York, pursuant to Public Law 85-159 which authorized the construction of certain works of improvement in the Niagara River for power and other purposes.

This new development begins about three miles above Niagara Falls and embraces the reach of the Niagara River between the City of Niagara Falls and Lewiston, New York, and contiguous areas within the City of Niagara Falls and the towns of Niagara and Lewiston. In this stretch of the river the water drops 314 ft. from the intake located above the Falls to the tailrace of the main power plant at Lewiston.

The main features of the project comprise a multi-ported intake of reinforced concrete; two covered conduits of reinforced concrete constructed by the cut-and-cover method to carry water from the intake above the Falls to the forebay of the reservoir pump-generating plant; a pump-generating plant; an artificially constructed storage reservoir; an unlined open canal by which water will be carried from the forebay of the pump-generating plant to the main powerhouse at Lewiston; the main generating plant at Lewiston; a switchyard and a new Niagara Parkway connecting North Grand Island Bridge with the Rainbow Bridge; and a vehicular bridge extending from the Niagara Parkway to Goat Island.

Power will be produced by 13 generating units at the main generating plant at Lewiston, each unit having an output of 150,000 kw. and totaling 1,950,000 kw. At the reservoir pump-generating plant, each of 12 motor-generating units will have a capacity of 20,000 kw. to produce a total of 240,000 kw.

The construction cost of the entire project is estimated at $625 million, the money to be raised by the sale of revenue bonds to private investors.

Public bids for the construction of the main power plant and appurtenances at Lewiston were received by the Power Authority of the State of New York on January 9, 1958. Merritt-Chapman & Scott Corporation's bid of $98,288,498 was the lowest and it was awarded the contract, officially known as Niagara Contract No. N3.

The first work being done by the contractor involves the construction of access roads and preparations for the relocation of international transmission lines carrying power from Ontario Hydroelectric Power Commission generating facilities across the Niagara River into the Niagara Mohawk Power Corporation system. Contracts for additional construction, equipment, and material will be awarded in May.

The Niagara River

The flow of the Niagara River comes from four of the Great Lakes, with a rainfall area of over a quarter million sq. mi. An average of 200,000 c.f.s. flows into the Niagara River. By the Treaty of 1950, the United States and Canada agreed that 100,000 c.f.s. must flow over the Falls in daytime hours during the tourist season. At all other times the flow over the Falls must not be less than 50,000 c.f.s. The balance of water available is divided equally between the United States and Canada for their use in the production of

Illustrations — courtesy, Power Authority of the State of New York

MAIN GENERATING PLANT: The canal and forebay to the left feed the by-passed water of the Niagara River to the 13 turbine-generator units. The switchyard in the background distributes the power.

hydroelectric power in the future.

Canada has already built power-generating facilities to use its share of the water. The Niagara Power Project being constructed by the Authority of the State of New York will use the United States' share of water made available by the Treaty of 1950. In addition, the project when completed will utilize approximately 20,000 c.f.s. previously allocated to the Niagara Mohawk Power Corporation by a license from the Federal Power Commission. This quantity of water will produce more power when used in the Authority's plant at Lewiston since the full drop of the river amounting to 314 ft. will be utilized, whereas the drop of water to the former Schoellkopf plant was only 215 ft.

International Aspects

The Treaty of 1950 with Canada provided for the preservation and enhancement of the beauty of the Falls. Under the direction of the International Joint Commission, Ontario-Hydro and the U. S. Army Corps of Engineers completed the construction of Remedial Works to assure that the terms and intent of the 1950 Treaty were fully met.

The Remedial Works consist of the Chippewa-Grass Island Pool control structure and two excavations on both flanks of the Horseshoe Cascades; also a 100-ft. crest fill on the Canadian flank and a 300-ft. crest fill on the Goat Island flank. The control structure regulates the flow of the river (over the Falls) and the water level in the pool where the intakes to the Canadian Sir Adam Beck power plants are located and where the Power Authority's intake will be located.

The Remedial Works also provide for a uniform flow over the crest of the Falls and permits withdrawal of water for power purposes by Canada and the U. S. without altering the beauty of the Falls.

Aggregate for Concrete

Aggregate for concrete for the various features of the Niagara project will be manufactured by an Authority contractor near the reservoir pump-generating plant, utilizing excavated rock of suitable quality from the open canal connecting the pump-generating plant with the main generating plant at Lewiston. Approximately 10,400,000 tons of manufactured fine and coarse aggregate will be required for the project.

The bedrock encountered at the project site will be dolomite, limestone, and sandstone interbedded with a thin stratum of shale. An extensive grouting program in selected areas of construction will be undertaken by the Authority to seal the bedrock.

Generating Plants

During daytime hours the water from the Niagara River will enter the intake structure located about three miles above the Falls and flow through an underground waterway consisting of two horseshoe-shaped conduits to the forebay of the pump-generating plant. From there it will flow through an open canal to the main plant at Lewiston. The water will then flow through the steel penstock tubes spinning the 13 turbines which drive the 13 generators producing 1,950,000 kw. of electricity.

The 1950 Treaty with Canada permits more water to be taken from the Niagara River at night. This extra water will also flow through the underground conduits to the forebay of the pump-generating plant. This plant is unique in that it will capitalize on the use of the surplus water made available at night. The pump-turbine units are utilized to pump water from the forebay into the storage reservoir. The pumps work at night, filling the reservoir. The following day this stored water is used to generate the extra power demanded by daytime needs.

When water flows from the reservoir, the electrically driven pumps of the night before are reversed to become turbine-generators and produce a quarter million kilowatts of additional electricity. Then the reservoir water joins the daytime flow from the river to the main generating plant to produce even more electricity. Together, the two plants will produce more than 2,000,000 kw. of electricity.

From the intake level above the Falls the water has dropped a total of 314 ft. to the lower river level at the main generating plant at Lewiston.

Main Generating Plant

The main generating plant at Lewiston will be among the world's largest hydroelectric power-producing plants. With its thirteen 150,000-kw.-installed-capacity generators, the plant will produce 1,950,000 kw. compared to the 1,947,000 kw. generated at Grand Coulee Dam on the Columbia River in the north-central section of the State of Washington.

SITE OF MAIN PLANT: The darker area in the above photograph defines the site of the main generating plant at Lewiston. In the foreground are the Canadian Sir Adam Beck generating stations.

RESERVOIR PUMP-GENERATING PLANT: Water is alternately pumped into, and withdrawn from, the reservoir in the background, depending on time and demand. Water from the Niagara River flows from right into the forebay at left and on to the main generating plant. The structure over the forebay carries cables to the switchyard.

Power at the Niagara generating plant will be generated at 13,800 volts, and, by the use of transformers, this will be stepped up to 115,000 and 230,000 volts for transmission.

The power plant will contain 13 vertical shaft Francis-type turbines, each with a capacity of 200,000 hp. at best efficiency under a net head of 300 ft.

The equipment to be installed in the reservoir pump-generating plant consists of 12 motor-generators, each with a capacity of 20,000 kw., to produce a total of 240,000 kw. of electricity; also 12 pump-turbines, each with a pumping capacity of 3,400 c.f.s. at 83-ft. head.

Project's Main Features

A multi-ported draft-distributor intake of reinforced concrete will be located about three miles above the Falls at the southern end of Hyde Park Boulevard in the City of Niagara Falls. This is the most advantageous location from the standpoint of reduced property damage, minimum interference with existing industrial development, and comparative ease of accessibility. The intake will be of reinforced-concrete construction, founded upon rock, and will consist essentially of a deep, heavy skimmer wall supported by concrete piers. The skimmer wall will act as a fender to prevent floating ice from entering the intake. The intake ports are located below the skimmer wall and consist of several liberal-sized openings between the concrete piers which support the skimmer wall. The salient feature of the hydraulic design is to withdraw water from the lower levels of the river for power development without interference with the downstream current in the upper levels. By this means, floating ice in the upper levels will continue downstream without entering the intake or accumulating against the skimmer wall. On the basis of hydraulic model tests, the ports will be designed to assure equal draft through all ports along the longitudinal axis of the intake.

Two Covered Conduits

Two covered conduits of reinforced concrete, constructed by the cut-and-cover method, will carry the water from the intake around the Falls to the forebay of the pump-generating plant, a distance of 21,500 ft. These two con-

INTAKES TO THE POWER CONDUITS: The intakes to the power conduits are located 2½ miles above Niagara Falls and well before the start of the rapids. The two structures house gates that control water flow into the 46-ft.-wide conduits.

duits will be of horseshoe shape, 46 ft. wide by 66 ft. high, and will have a capacity of about 83,000 c.f.s. under a velocity of 14.0 ft. a second. This capacity is sufficient to operate the main plant at best efficiency and average head. Structurally, the roofs of the conduits will be designed as three-hinged arches with simplified movable hinges to accommodate any anticipated lateral movement owing to release of internal stresses caused by excavation of the foundation work.

Pump-Generating Plant

A pump-generating plant will be of the outdoor type of reinforced-concrete construction and designed to house 12 generator-motor units rated at 20,000 kw. as generators and 28,000 kw. as motors. The pump-turbines will each have a pumping capacity of 3,400 c.f.s. at 83-ft. head and a generating capacity of 27,500 hp. at 75-ft. head. The speed of operation will be 112.5 r.p.m. The units will have the largest diameter Francis-type runner (205 in.) that the manufacturers recommend at this head for fabrication and shipment in a single piece.

The step-up transformers will be located at the generator deck level between the intake and turbine substructure sections of the powerhouse.

To afford the requisite insurance against cavitation when operating as pumps, the machines will be set with the center line of the distributor at elevation 550 and the bottom of the runner at elevation 544, or 5 ft. below elevation 549, the estimated minimum tailwater elevation during pumping. To facilitate starting on the pumping cycle, a tailwater depressing system will be necessary to limit the starting current as the pumps are brought up to synchronous speed and placed on the line before the wicket gates are opened to absorb the pumping load. Consideration will be given to the selection of movable blade, propeller-type runners if these are made available by American manufacturers.

Transformers—Reservoir Plant

Transformers in the reservoir plant to step down the 115-kv. transmission voltage to the motor or generator voltage will each be rated 100,000 KVA or three times the motor-generating rating. Low-voltage leads from the transformer to the bus for three units will be of isolated-phase construction. Connections between the bus and each unit will be made through one of two air-circuit breakers, of 2000-amp. 1,000,000-KVA interrupting capacity. Leads through one breaker will be transposed to provide reverse rotation when operating as a motor. A neutral air-circuit breaker and possibly also a neutral resistor or reactor will be provided for each unit.

An artificially constructed storage reservoir with a capacity of 60,000 acre-feet will store and make available for power purposes the increased amount of water that may, under the 1950 Treaty, be diverted at night. The reservoir will be located about one mile from the Lewiston powerhouse, and will be encompassed by a rolled-earth and rock-fill embankment. In this location the topography is flat and there is available suitable embankment material, also tight clay, for a reservoir bottom. The storage capacity will be sufficient to firm-up the lowest week's flow of record to the minimum monthly average during the critical months of October and December.

Unlined Open Canal

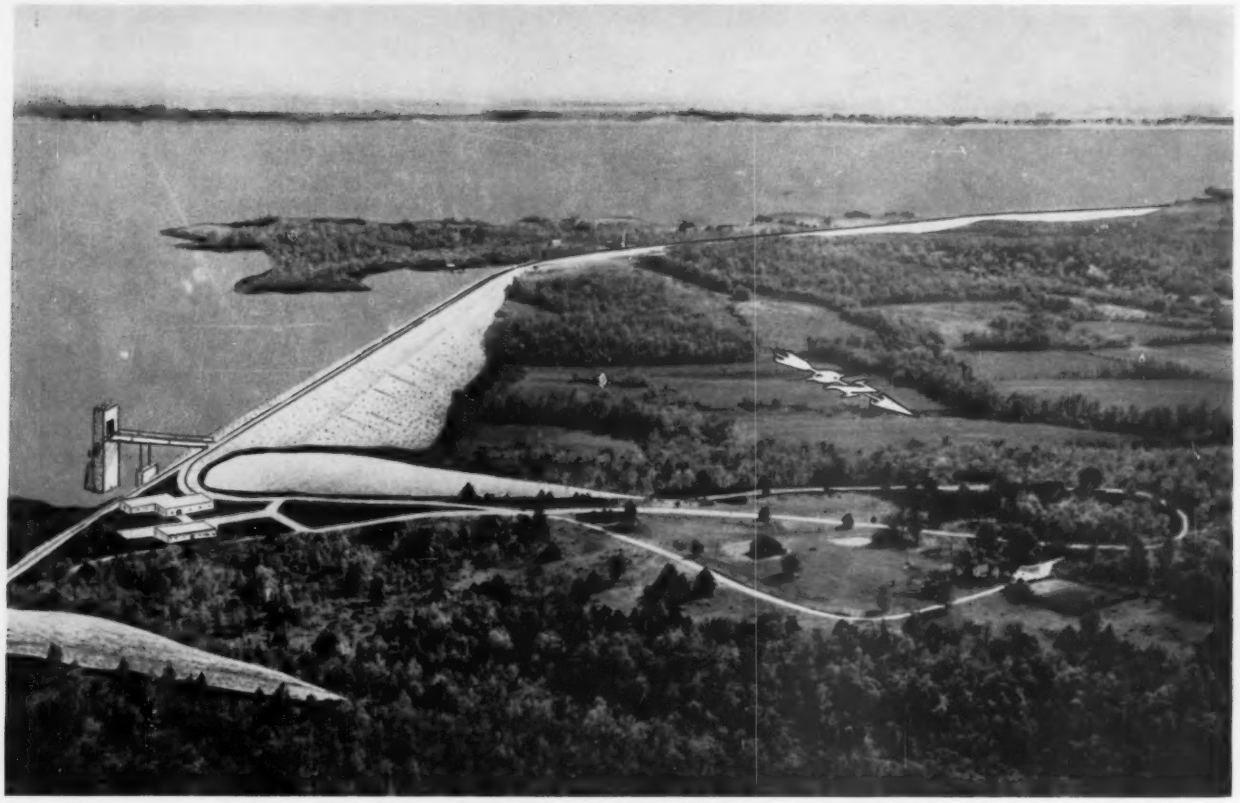
An unlined open canal will be constructed to carry water about one mile from the forebay of the pump-generating plant to the main powerhouse at Lewiston. This canal with the appurtenant forebays will also serve as a surge basin to accommodate load demand and rejection.

The main power plant at Lewiston will consist of an intake structure with head gates and forebay at the top of the cliff, plate-steel penstocks between the intake and power station, and a generating station proper located at the bottom of the cliff.

The elevation of the water surface at the river intake of the proposed job

(Continued on page 60)

NEW BRIDGE TO GOAT ISLAND: This is a view looking west along the American rapids toward the mist of the Falls with Goat Island at left. The new Niagara Parkway, at right, will greatly improve vehicular access to the island and permit the preservation of the old bridge for pedestrians and tractor train.



AN ARTIST'S CONCEPTION: This is an artist's conception of the Pomme de Terre Dam, a threefold construction project of the Corps of Engineers, U. S. Army, across the Pomme de Terre River in the foothills of the Ozark mountains three miles south of Hermitage.

Pomme de Terre Dam in Missouri

A structure recently completed near Hermitage is one in a system of nine dams in the Army Engineers' program to control floods and improve low-water controls in the Osage Basin of Missouri and Kansas

L. H. HOUCK*

POMME DE TERRE DAM across the Pomme de Terre River, three miles south of Hermitage, Missouri, in the foothills of the Ozark mountains, is a threefold construction project of the U. S. Army Corps of Engineers. Primarily designed for flood control, the dam will also control low-water flows and water supply and will create one of the nation's important scenic recreational areas.

The estimated cost of the dam and reservoir is $18,700,000, which will be wholly paid by the Federal Government. The assumed financial life of the dam, as projected by studies of Army Engineers, is 50 years, in which time the gainful returns will be equal to, or greater than, the cost.

However, the most important aspect of the project is its physical and operational life, which can be counted in

*400 Linden Drive
Jefferson City, Missouri

DIFFICULT ROCK EXCAVATION: This view is typical of the variable rock formations encountered on the project. Holes for blasting were drilled 12 ft. deep, 7 ft. apart, with a 7-ft. burden, on 12-ft. benches by Joy wagon drills.

the hundreds of years. Future generations will enjoy the benefits of a large recreational area with conservation lakes and a scenic shoreline more than 100 miles long. Natural advantages inherent in the site provide bluffs, hills, and outstanding scenic beauty. The hand of man will rework nature but slightly to provide scenic roads, camping areas, boat-launching ramps, pure drinking water, sanitary facilities, and concession and supply services.

While these advantages are intentionally incorporated in the project, the basis on which such a project must stand when built with public funds is that of immediate urgency. So, it primarily fills a long-standing need for a method of controlling periodic and damaging floods in the Osage Basin in Missouri and Kansas.

In the past 34 years, the flood stage at Hermitage, Missouri, has been equaled or exceeded 58 times. As the principal tributary of the Osage River, known in Kansas as the Marais des Cygnes River, the Pomme de Terre has been a major contributor to disastrous floods on the Osage, the Missouri, and the Mississippi Rivers, in addition to flooding its own valley. The Osage flows 495 miles eastward from its source to empty into the Missouri near Jefferson City.

The Pomme de Terre has its source near Marshfield, Missouri, and flows generally north, emptying into the Osage in Benton County.

One of a Nine-Dam System

Pomme de Terre Dam is one of a nine-dam system which Congress has authorized the Corps of Engineers to build in the Osage Basin of Missouri and Kansas for flood control and the improvement of low-water flows. It is one of three in a group for which hydroelectric power is authorized. Facilities for power production have been deferred for the present.

The possibilities of building the Pomme de Terre Dam were investigated as early as 1929. It became a unit in the overall Missouri River basin flood-control plan in 1933, and, in 1938, construction was authorized by Congress.

The start of work on the dam was assured when the President's 1956 budget included $500,000 for initial construction. This was increased to $800,000 by a subsequent act of Congress, which was approved by the signature of President Eisenhower on July 2, 1956.

Construction Details

The George Bennett Construction Company, Kansas City, Kansas, was awarded a contract for the initial construction phase of Pomme de Terre Dam in January, 1957. The company moved its equipment to the site in February. The contract was completed on March 18, 1958, after some delays because of bad weather and high water.

A contract for $32,721 was awarded April 18, 1957, to A. L. Myers, for construction of a temporary office, pump house, and other facilities at the dam site.

The Pomme de Terre Dam is a composite rock- and earth-fill embankment that stretches 7,420 ft. across the valley. There is an earth-fill dike on the left abutment, an uncontrolled chute spillway through the right abutment, and a gate-controlled outlet tunnel for flood control and stream-flow releases. The overall length includes 4,630 ft. in the main embankment and 2,790 ft. in the dike portion. The main embankment is 155 ft. above the stream bed with a width at the base of 956 ft. The drainage area consists of 611 sq. mi. or about 74 per cent of the Pomme de Terre basin. The reservoir has a gross capacity of 650,000 acre-feet (one acre-foot equals 325,850 gal.) and a surface area of 16,100 acres.

At conservation pool elevation of 839 ft., the permanent lake will extend about 19 valley miles upstream from the Pomme de Terre River and about 13 miles on nearby Lindley Creek. Full pool water impoundment, expected only on rare occasions, will extend about 28 valley miles upstream.

The conservation and sediment allocation has a capacity of 243,000 acre-feet and a surface area of 7,820 acres.

The reservoir will provide protection to 5,000 acres along the banks of the Pomme de Terre between the dam and the upstream limits of the authorized Kasinger Bluff Reservoir. Operating in conjunction with other reservoirs in the Osage system, it will contribute substantially to protection of 26,600 acres along the lower Osage River and to 160,000 acres of highly developed agricultural land along the Missouri River. Control of the Pomme de Terre will also be reflected in the lowering of stages on the Mississippi River.

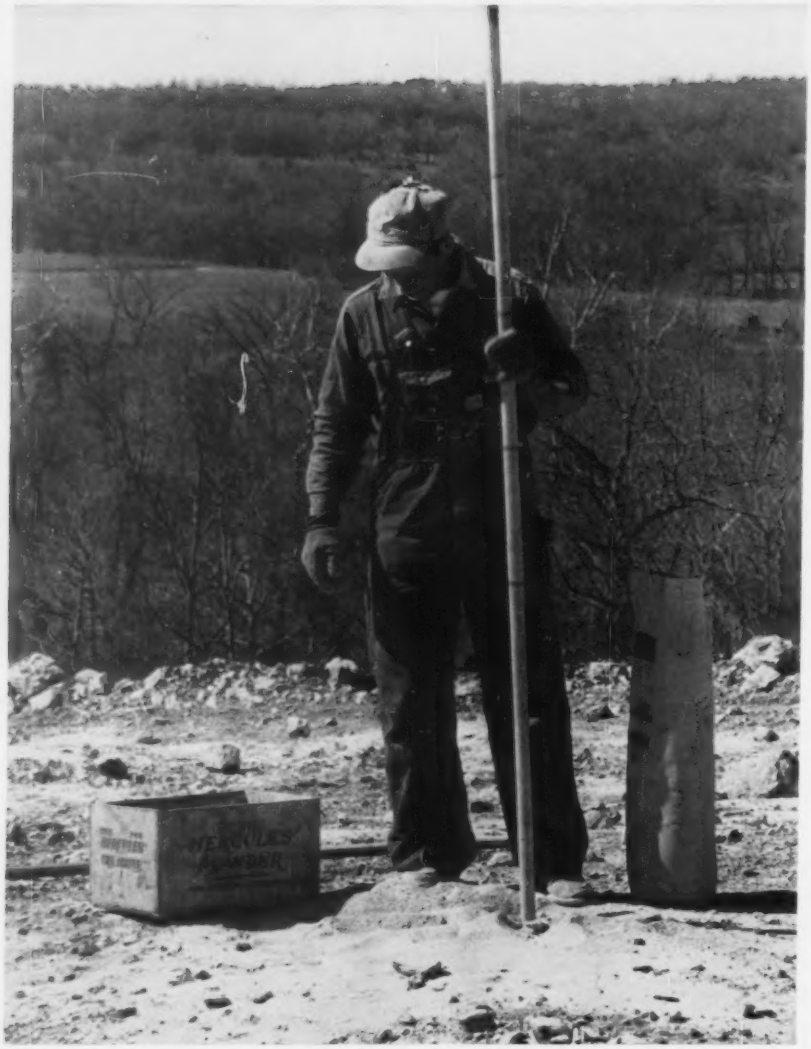
A valuable feature is that, in addition to flood control, the Pomme de Terre Reservoir will provide conservation storage of water which will be drawn upon to keep rivers flowing in times of drought, thus increasing the water supply for agricultural and municipal uses and diminishing health hazards resulting from pollution.

The first phase of construction handled by the George Bennett Construction Company consisted principally of 408,000 cu. yd. of foundation excavation, and 394,000 cu. yd. of rock excavation in the inlet and outlet channels.

Geology of Region

While excavation work in this area

JOY COMPRESSOR: A close-up of one of the Joy compressors that supplied air power for the pneumatic equipment used by the contractor on the Pomme de Terre Dam project in Missouri.



LOADING EXPLOSIVES: Each blast hole in the 12-ft. bench sections was loaded with a combination of Hercules Extra Dynamite 60% and nitro carbo nitrate blasting agents primed with short-period delay electric blasting caps.

is not considered difficult, the rugged terrain does present problems, and the rock sections are fraught with surprise situations.

The upland areas and gentle valley slopes are covered with a thin soil mantle derived chiefly from the dolomite and limestone bedrock and, generally, of a residual and clay composition. The river flows on bedrock at the dam site near elevation 750 ft., close to the toe of the right abutment bluff.

Overburden on the left abutment slope runs 3 to 10 ft. thick. It consists of a thin, gray topsoil, underlaid with a lean and gravel-filled clay.

The bedrock that forms the abutments and valley floor is chiefly a dolomite of the lower Ordovician series, known as the Jefferson City formation. The Cotter formation, which is similar and which lies above the Jefferson City, was encountered in the spillway excavation in the right abutment. The original mass succumbed in prehistoric times to the process of dolomitization, which is said to account for the many variations in the bedding of the Jefferson City and Cotter formations.

Dolomitization is interesting here because the rock structure provides high resistance to blasting forces on the one hand and contains all the potentials for frequent blowouts on the other hand, owing to pits and small cavities that are characteristic of dolomitization which takes place when the mass is plastic.

The rock formations consist of Burlington limestone, 100 ft. thick; Choteau limestone, 55 ft.; Cotter dolomite, 110 ft.; Jefferson City dolomite, 210 ft.; and Roubidoux sandstone, 110 ft. thick.

While the drilling and blasting crews of the Bennett company had trouble with such a variety of rock formations, the Corps of Engineers had to consider earthquake shock in designing the dam. Even though the area is not active seismically, it lies about 200 miles northwest of the New Madrid, Missouri, epicenter where one of the major earthquakes of record occurred in 1811. Several other minor shocks have been experienced in this area subsequent to the 1811 earthquake.

The bedrock excavations, which required systematic drilling and blasting, were not conducive to producing dolomite of concrete quality. Poor results from laboratory tests indicated conservative use as riprap.

The approach and outlet channels included in the preliminary contract awarded to the Bennett company consisted of large open cuts. The broken rock produced was used in the rockfill section. Rock bolting will be used in future areas of weak, slabby, or closely jointed rock. Much of the finished sections in sides and bottoms may be grouted with cement in the final stages of construction.

The equipment used by the Bennett organization consisted of two 2½-cu. yd. Northwest shovels, powered with Murphy diesels; two Joy wagon drills; four Euclid bottom-dump trucks of 13-cu. yd. struck capacity; two Joy air compressors; three 24-cu. yd. cable-dump rock trailers with 2-wheel Caterpillar tractors; two Caterpillar crawler tractors with dozers; a Caterpillar motor grader; and many other miscellaneous units.

Drilling and Blasting

The initial procedure involved the dozing off of the thin overburden and then blasting the rock in 12-ft. benches.

From 80 to 90 holes were usually drilled for each blast, mostly on a 7 by 7-ft. pattern. The drills were equipped with 1¼-in. octagon steel and 3-in. Timken detachable bits.

During the writer's visit to the project, the 12-ft.-deep holes were loaded with Hercules® nitro carbo nitrate blasting agents with 2 by 8-in. cartridges of Hercules® Extra Dynamite 60% placed at 3-ft. intervals. The holes were stemmed to the collar with drill cuttings. An average blast consisted of 800 lb. of nitro carbo nitrate and 200 lb. of Hercules Extra Dynamite 60%.

Because of the variations in the rock formations and the degrees of weathering and hardness, the throw of blasted rock varied considerably. One of the problems was the presence of random pockets of wet clay and water that had been trapped in the formation in some prehistoric age. Extra care in doing a tight stemming job helped in getting satisfactory blasting results. Fragmentation was such as to make for normal loading by 2½-cu. yd. shovel dippers. Secondary blasting was seldom required.

The charges were primed with Hercules® Short-Period Delay Electric Blasting Caps, from 1 to 6 periods of delay. Blasts were fired with a conventional blasting machine. The usual procedure was to fire the blasts at noon and at the close of work at 5 p.m.

Loading Equipment

After blasting, the broken rock was loaded into a fleet of four Euclid FDT 13-cu. yd. bottom-dump trucks and three Move-All 24-cu. yd. cable-dump units powered with Caterpillar 2-wheel pneumatic-tired tractors.

Loading equipment consisted of two 2½-cu. yd. Northwest shovels, powered with Murphy diesels. These units were able to do an excellent job of picking up both the large rock and the fines. As a result, a minimum of secondary cleanup was required. A Caterpillar with high lift loaded out overburden, which was dozed off the hilltops by two Caterpillar crawler tractors with dozer blades.

Haul roads were long, winding, and beset with considerable grades during the early part of the contract, but were kept clear with a Caterpillar No. 12 motor grader.

Unlike some big dam locations where landowners set up resistance to construction, the Pomme de Terre Dam is heralded both as a flood control and an economic boon to the area. Hermitage, Missouri, may become the center of a rich resort area in the fu-

REMOVING BLASTED ROCK: Combinations of hard dolomite, layered limestone, and weathered rock interspersed with clay and water pockets posed many blasting problems. However, power shovels loaded out the broken rock easily and no secondary blasting was necessary.

CELEBRATION CEREMONIES: Honorable Stuart Symington, U. S. Senator from Missouri, delivered the principal address at the celebration ceremonies held at the dam site on October 19, 1957.

ARMY PROJECT SUPERVISORS: Roy Dean, embankment supervisor, at left; F. M. Fahy, project engineer; and Charles Byers, assistant inspector; supervised construction details for the U. S. Army Corps of Engineers.

ture. Consequently, a dam celebration held October 19, 1957, was attended by several thousand persons. The principal speaker at the affair was the Honorable Stuart Symington, U. S. Senator from Missouri.

It is expected that additional contracts will be let this year, and an amount of $3,000,000 was included in the present budget.

Key Men

Bennett Construction Company is a well-known company and has handled many large contracts in the 12-state Pick-Sloan flood-control area. The company's engineer on this job was Jack Bowerman and its general superintendent was Glenn Kessler.

F. M. Fahy, project engineer, represented the Corps of Engineer, U. S. Army. The Pomme de Terre job is in the Kansas City District where L. E. Laurion is district engineer.

Cuba's Hanabanilla Hydroelectric Project

Completion of a Government-sponsored $17-million construction program will provide low-cost electricity for the island's rapidly expanding needs

EDUARDO J. CASTELLANOS*

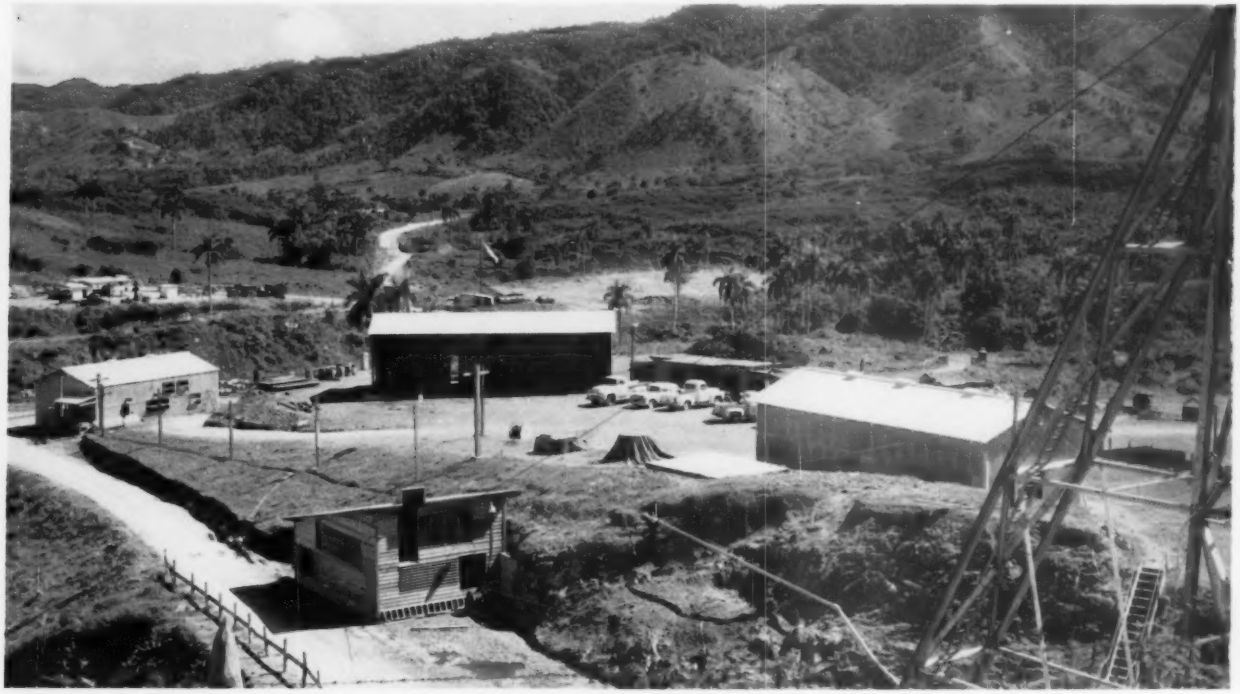
WITH the award of Contract C-1 to Tecon Corporation of Dallas, Texas, on January 1, 1956, the Government of Cuba sponsored its first hydroelectric project, estimated to cost more than $17,000,000. Upon completion of the project, known locally as the Hanabanilla Project, it will furnish low-cost electricity for Cuba's rapidly expanding industrial and domestic needs and bring electric power to rural areas not heretofore supplied.

*Vice President
Minagro Industrial, S.A.
Havana, Cuba

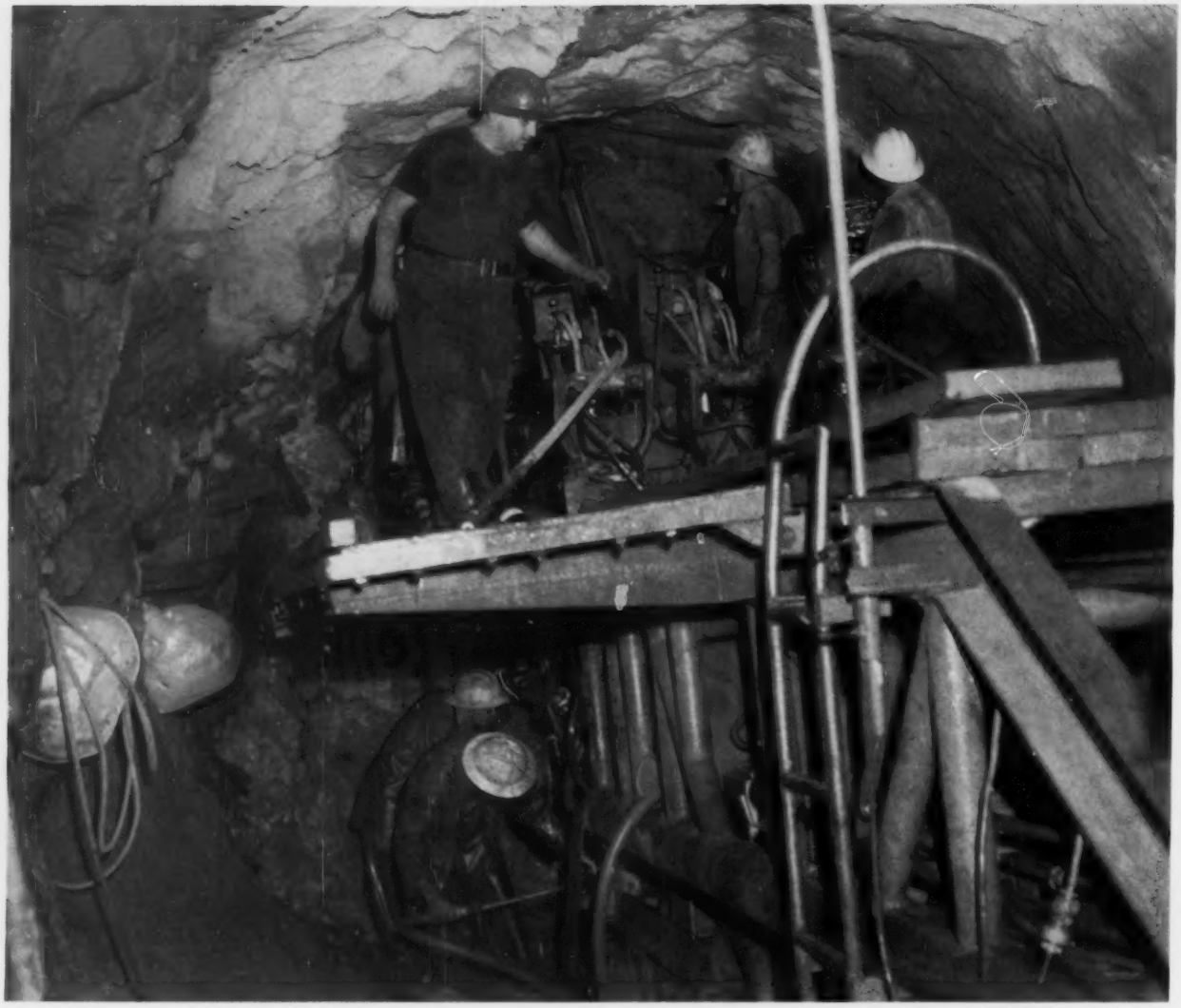
Designed by the engineering firm of Tippetts-Abbett-McCarthy-Stratton of New York City for Primera Central Hidroeléctrica Cubana, the operating agency for the Cuban Government, the project will consist of two earth-fill dams and the resulting reservoir of more than 76-billion-gal. capacity; a vertical intake structure; an inclined service tunnel; an underground powerhouse; and an outlet or tailrace tunnel.

Rugged Terrain

The location of the project is in the south-central part of Las Villas Pro-



PROJECT SITE: Cuba's Hanabanilla Project is located in the south-central part of Las Villas Province about 31 miles east of Cienfuegos. The watershed created by the mountains at this location covers an area of about 77 square miles. This assures a plentiful supply of water for the operation of the generating equipment.



DRILLING BLAST HOLES: For blasting a heading in the tailrace tunnel a round of holes is drilled by a battery of Gardner-Denver drifter drills mounted on a jumbo with 120-in. hydraulic booms.

vince about 31 miles east of Cienfuegos. The rugged Sierra de San Juan, of medium elevation ranging up to 3,280 ft. in height, is characteristic of the topography of the project site. The area has been eroded by heavy rains and the many rivers that originate in the upper elevations. The watershed created by the mountains at this location covers an area of about 77 sq. mi. This assures a plentiful supply of water for the hydroelectric station.

There are three major rivers in the project area: the Hanabanilla, the Negro, and the Guanajara. Water from these rivers will be diverted to the reservoir and then channeled to the penstock shaft leading to the powerhouse to provide the energy for the operation of the generating equipment.

The specifications for the removal of earth and rock in Contract C-1 consist of 98,100 cu. yd. of open-cut excavation in the intake channel; 160,230 cu. yd. of rock for the tailrace tunnel; 4,185 cu. yd. of rock for the penstock shaft; 16,088 cu. yd. of rock for the service tunnel; and 19,227 cu. yd. of rock for the underground chambers.

Subsurface explorations indicated that the formations in the areas to be excavated were predominantly dioritic gneiss, a granitoid-layered type of rock with some cleavage. However, in the tailrace tunnel excavation the contractor's drillers encountered a somewhat different situation. The bedding planes were perpendicular to the direction of the heading with occasional slips of strained, highly weathered diorite with open joints lined with clay or sand-sized particles. In some instances these slips made it necessary to install supports to maintain the excavation. Water-bearing seams and constantly changing rock conditions necessitated the carrying of 16-ft. feeler holes ahead of the excavation as a safety measure for the protection of the men.

The Penstock Shaft

Drilling in the penstock shaft was done with four S-55W Gardner-Denver sinker drills using 1½-in. chisel bits with 1-in. hexagonal Atlas Copco rods. Air was supplied by two Gardner-

Denver, Model RP 600, rotary portable compressors. The penstock shaft was sunk by the bench method. A typical drill round consisted of 28 holes 1½ in. in diameter, 6 ft. deep, spaced on 2-ft. centers. They were loaded with approximately 90 lb. of Gelamite® 2-X. This explosives loading factor averaged 4.0 lb. of dynamite per cu. yd. of solid material.

The charges of dynamite in the holes of the shaft rounds were primed with Hercules® Delay Electric Blasting Caps with 12-ft. leg wires, using 1 to 7 periods of delay. The cap wires were hooked up in parallel, connected to bus wires, and blasts were fired by a 440-volt power line.

There were two big advantages in sinking the penstock shaft by the bench method of drilling and blasting. First, hand-mucking was made easier because the blast usually threw most of the muck to one side of the shaft and it was easy to hand-shovel the blasted material into the 2¾-cu. yd. bucket in the cut. Two buckets were utilized, one being loaded while the other was being hoisted for dumping into the spoil chute. The muck was transported to the spoil area by Koehring Dumptors. Second, this method provided a continuous sump to collect the water that drained into the shaft, made pumping easier, and made possible a dry bench for drilling and blasting operations.

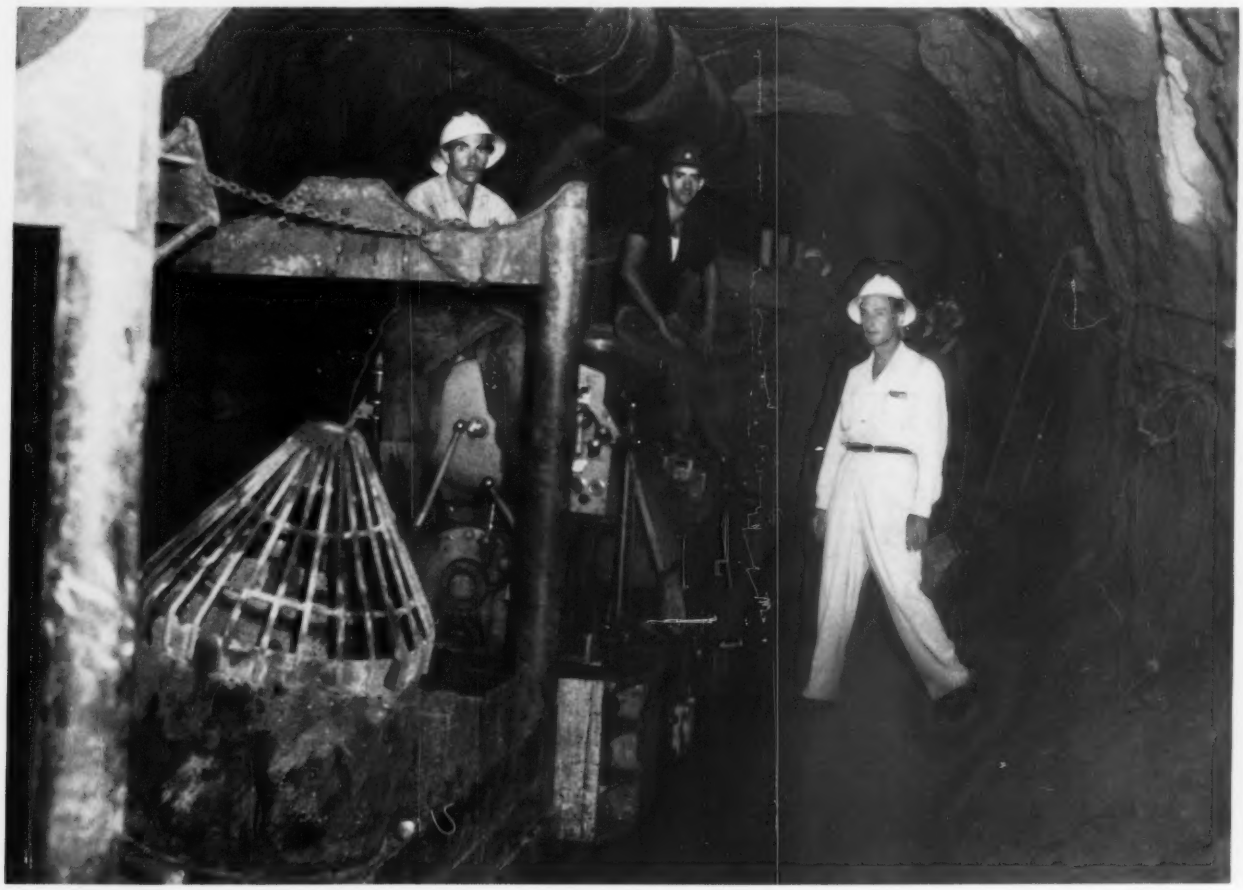
The Tailrace Tunnel

The tailrace tunnel that will carry the water to Hanabanilla River after its trip through the generating turbines will be 22,000 ft. in length with an unlined diameter of 14.1 ft., on a slope of 0.00157.

Drilling holes for blasting in the tailrace tunnel was done with a battery of five Gardner-Denver SF-93P drifter drills, mounted on a jumbo with 120-in. hydraulic booms. The drills were equipped with Crucible drill steel 1¼ in. in diameter and 1⅝-in. and 1¾-in. Timken carbide insert detachable bits. Three Gardner-Denver, Model RP 600-D, rotary portable compressors supplied the air for all the drilling needs in the tailrace tunnel.

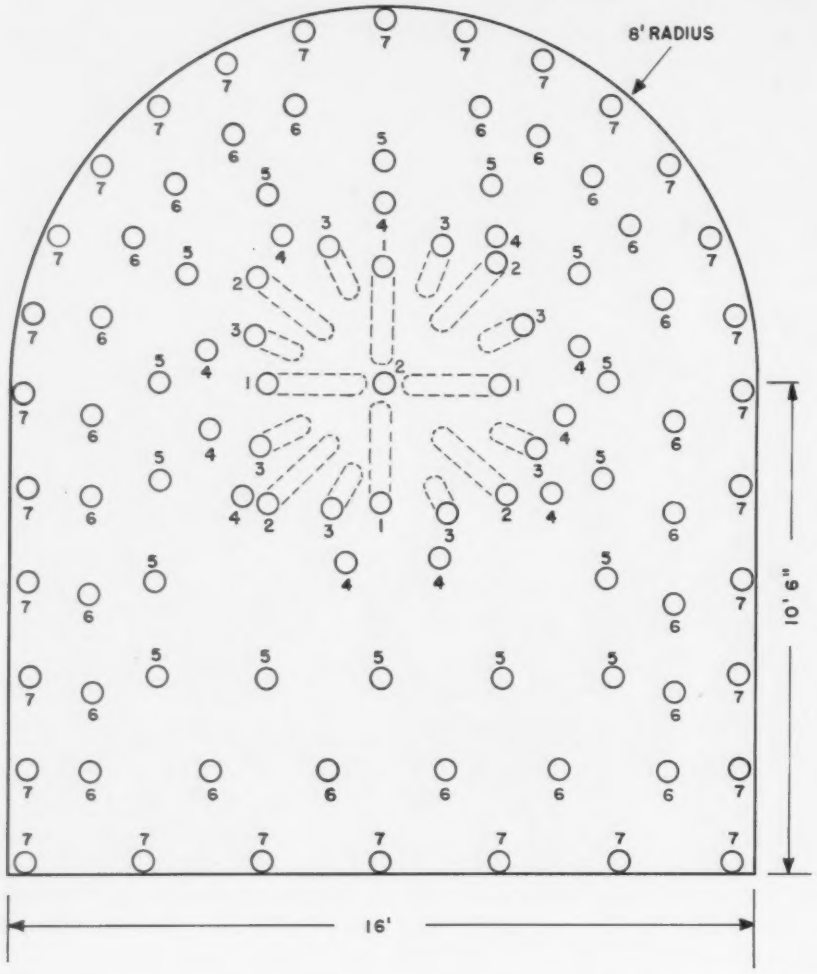
In driving the tailrace tunnel the usual drill round comprised 47 holes 1¾ in. in diameter on 2-ft. centers. The depth of the holes was either 8 or 10 ft., depending on the hardness of the rock. Each round included a 5-hole burn cut. Hercules Delay Electric Blasting Caps, periods 1 to 9, 12-ft. leg wires, connected in parallel initiated the blast. The explosives loading factor was 3.0 lb. of dynamite per cu. yd. of material. The total amount of explosives used in a round varied from 250 to 350 lb. of Gelamite 2-X in 1¼ by 8-in. cartridges, depending upon the depth of the drill hole.

Mucking operations in the tailrace tunnel were done with Eimco Model



DELIVERING EXPLOSIVES UNDERGROUND: The explosives required for blasting in the tailrace tunnel headings were delivered in a specially designed portable magazine hauled by a Plymouth diesel locomotive.

LOADING DYNAMITE CHARGES: After a round of blast holes was drilled into a heading in the tailrace tunnel they were loaded with 1¼ by 8-in. cartridges of Gelamite 2-X, using a loading ratio of 3.0 lb. of dynamite per cu. yd. of rock in place.



DRILL ROUND IN SERVICE TUNNEL: Blasting in the 42-degree inclined service tunnel 1,115 ft. long and 16 ft. wide, required a round of 84 drill holes, each hole 1¾ in. in diameter, 8 ft. deep, on 2-ft. centers. The holes were loaded with 3.5 lb. of Gelamite 2-X per cu. yd. of rock in place. Each charge was primed with a Hercules Delay Electric Blasting Cap, 1 to 7 periods of delay. The numbers alongside the holes in the drawing indicate the order of firing the charges.

40 machines that discharged into 5-cu. yd. cars. The switching of the muck cars was done with a standard car passer. To complete mucking out operations in a normal tailrace tunnel round 16 cars were needed. A full muck train was transported to the portal by Plymouth 8-ton diesel locomotives. At the portal the cars were pulled up the ramp by a 15-ton diesel-driven Clyde hoist and an HD20 Allis-Chalmers tractor and dumped by two hydraulic rams.

The Service Tunnel

Blasting in the 42-degree inclined service tunnel, 1,115 ft. long and with an unfinished width of 16 ft., required an 84-hole drill round. These holes were 1¾ in. in diameter, 8 ft. deep, and on 2-ft. centers. The round was loaded with an average of 275 lb. of Gelamite 2-X, in 1¼ by 8-in. cartridges.

This represented a loading ratio of 3.5 lb. of explosives per cu. yd. of rock in place. Hercules Delay Caps, 1 to 7 periods of delay, connected in parallel, were used to detonate the charges of dynamite.

At present, mucking in the service tunnel is done by hand while awaiting the holing-through of the service tunnel raises from the powerhouse chamber. A 3-cu. yd. skip is loaded and dumped directly into a Koehring Dumptor by means of "pony back" wheels riding on steeply inclined outside rails attached to the head frame.

The excavation of the 19,227 cu. yd. of rock for the valve chamber and powerhouse foundations has not yet started. It is planned to excavate the arch first, then bench the remainder after concreting the arch. The proposed procedure is to drill and blast the arch in three sections. First the center section, 9 by 12½ ft., is to be drilled with 54 holes, 1½ in. in diameter, each 8 ft. deep. This includes a 9-hole burn cut. Then alternately or jointly, the end sections will be drilled and blasted, with the previously fired center serving as an open cut. The drill round in each section will comprise 27 holes of the same size and depth as the center section. It is estimated that 450 to 550 lb. of explosives will be required for the three sections. A loading factor of 3.0 lb. of Gelamite 2-X per cu. yd. is anticipated. Hercules Delay Electric Caps, 1 to 9 periods for the center cut and 1 to 8 periods for the end cuts, connected in parallel, will be used to detonate the rounds.

Mucking of the valve chamber and powerhouse will be done with Ingersoll-Rand scraper units slushing into muck raises. From the muck chute a 3½-cu. yd. skip is loaded, raised through the completed shaft, and automatically dumped into a 33-cu. yd. muck bin. Haulage to the spoil area will be done by Koehring Dumptors. After the underground chambers are completed, the muck chutes will be backfilled and grouted. When the service tunnel is completed, the muck from the powerhouse blasting operations will be chuted into the service tunnel skip for removal, while the shaft facilities are used for concreting the valve chamber arch.

The Tecon Corporation employs more than 260 men on the Hanabanilla project. A camp was established for the contractor's employes in the headquarters area, complete with barracks, recreational facilities, and dining halls. Office structures, warehouses, and repair facilities are also included in the area.

Three Contracts

All construction work is being carried out under three contracts: C-1, covering underground excavation; C-2, covering dam construction; and C-3, covering construction of the transmission line, power facilities at the underground power cavern, and "cleanup" of all remaining odds and ends.

In addition to Tecon, the C-1 contractor, there are also at the job site the crews of "Ingeniería G. del Valle, S.A.," a well-known Cuban engineering firm, which is the C-2 contractor. This firm was also recently awarded Contract C-3.

Three autonomous institutions have combined financial and executive resources in setting up Primera Central Hidroeléctrica Cubana (PRICHEC). The Board of Directors is made up of Emeterio S. Santovenia, president, representing Banco de Fomento Agrícola e Industrial de Cuba; Amadeo López Castro, director, representing Comisión de Fomento Nacional de Cuba; Esteban Alfonso, director, representing Financiera Nacional de Cuba. Eugenio Castillo, representing Banco Nacional de Cuba on the Board of

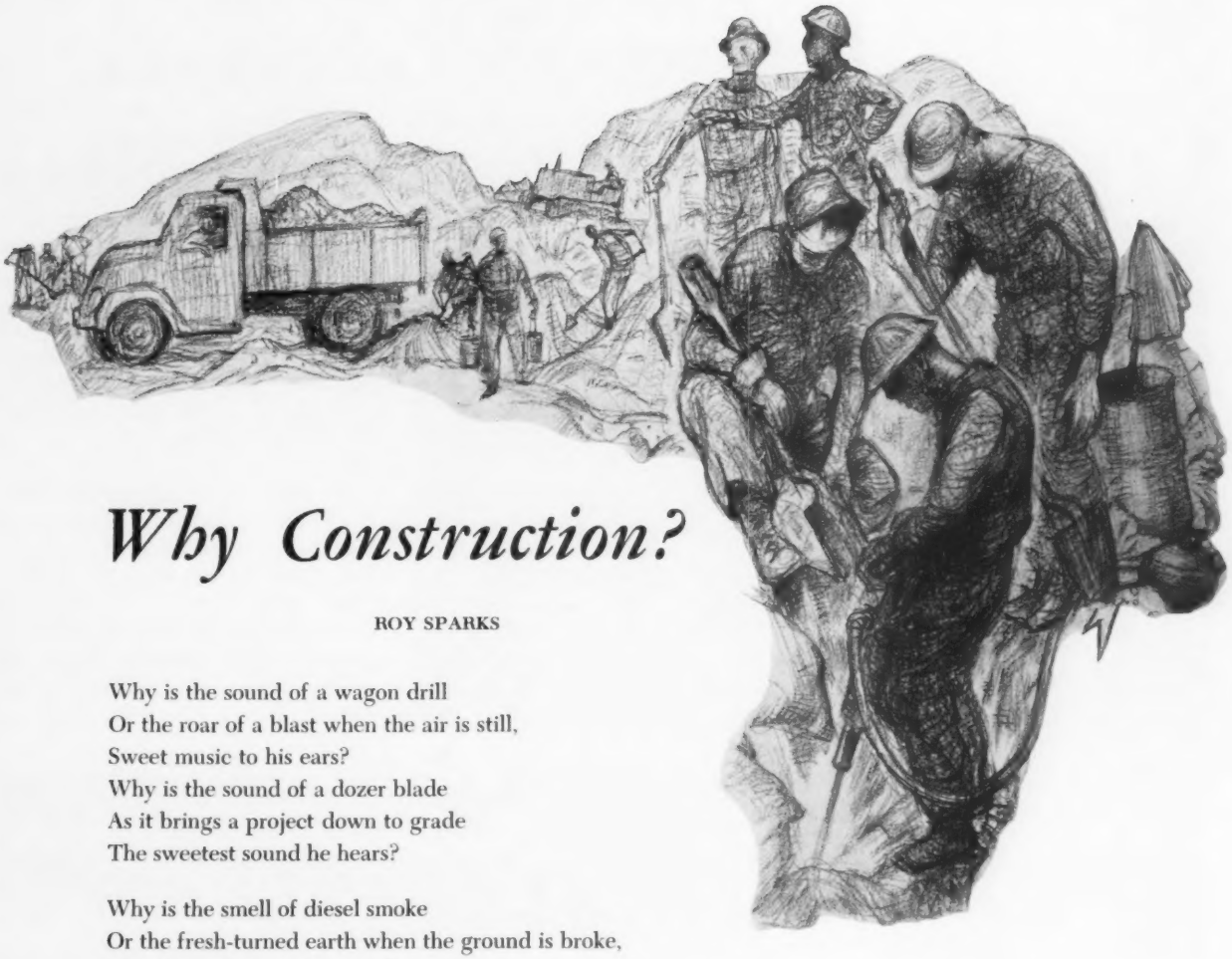
MECHANICAL MUCKING: After a blast in the tailrace tunnel, the muck was loaded out with Eimco Model 40 machines into 5-cu. yd. cars and transported to the portal by Plymouth 8-ton diesel locomotives.

OPERATING SUPERVISORS: Some of Tecon's operating supervisors on the Hanabanilla Project included, back row, left to right: Karl Keener; Fiore Gubert; Joseph Swicegood; A. O. McFadden; George Boone; Jack Logan; Charles Phillips, project manager; Allen Depew. Front row left to right, Herman Fossum; Adam Basaraba; Lee Lowry; John Perme; Harry Van Doren; Ernest Carlson.

Directors of Banco de Fomento Agrícola e Industrial de Cuba, is PRICHEC's general manager. Fernando Ganivet, secretary of Banco de Fomento Agrícola e Industrial de Cuba, is also secretary of Primera Central Hidroeléctrica Cubana (PRICHEC).

The executive personnel for Primera Central Hidroeléctrica Cubana includes Emeterio S. Santovenia as president and Eugenio Castillo as general manager. The supervisory personnel for the Tecon organization includes Charles W. Phillips, project manager, and John W. Perme, project engineer. Representatives of the engineering firm of Tippetts-Abbett-McCarthy-Stratton at the project are Phillip S. O'Shaugnessy, chief engineer, and Russell Roddy, field engineer.

INCLINED SERVICE TUNNEL: After a blast was fired in the inclined service tunnel, the muck was hand-loaded into a 3-cu. yd. skip, hoisted to the surface and dumped into a Koehring Dumptor by means of "pony back" wheels riding on rails attached to the head frame. Mechanical mucking was used in this operation after the service tunnel raises were holed through.



Why Construction?

ROY SPARKS

Why is the sound of a wagon drill
Or the roar of a blast when the air is still,
Sweet music to his ears?
Why is the sound of a dozer blade
As it brings a project down to grade
The sweetest sound he hears?

Why is the smell of diesel smoke
Or the fresh-turned earth when the ground is broke,
The things he loves the most?
Or the taste of dust and the smell of sweat
A lifetime spent with no regret
Of which he loves to boast?

Why does each day a challenge bring –
Summer, winter, fall, or spring –
A challenge he must meet?
A truck that's stuck
In the mire and muck,
A problem he must beat.

Why is the rattle, jump, and jerk
Merely a part of his daily work,
Along with the wear and tear
And the constant whine
As the gears grind
A part of his bill of fare?

Why is the spot
Where the sun is hot,
And action hotter still,
The place he'll find
Real peace of mind
Because he fills the bill?

Why does he go
Through sleet and snow
Or rain or hail or mud?
Regardless of season
There is a good reason –
Construction's in his blood.

*Route 12, Box 125, Kirkwood, Mo.

Explosives Seal Entrances To Abandoned Limestone Mine

Dynamite removes the supporting pillars of an abandoned limestone mine to effectively seal the workings from trespassers

L. F. SERENO*

SINCE 1862 Menke Stone and Lime Company has been operating limestone mines in the high bluff overlooking the Mississippi River at Quincy, Illinois. Tunnels driven deep into the bluff produced a high-quality limestone which the Menke organization made into hydrate lime, pebble lime, and agricultural limestone.

As with most mines and quarries, there comes a time when insufficient or low-grade rock or ore makes it no longer feasible to continue operations. Such a condition occurred about 50 years ago when certain workings failed to produce limestone high enough in quality to meet the rigid specifications of the Menke company. A section of the mine was abandoned and operations transferred to other sections where the limestone met specifications.

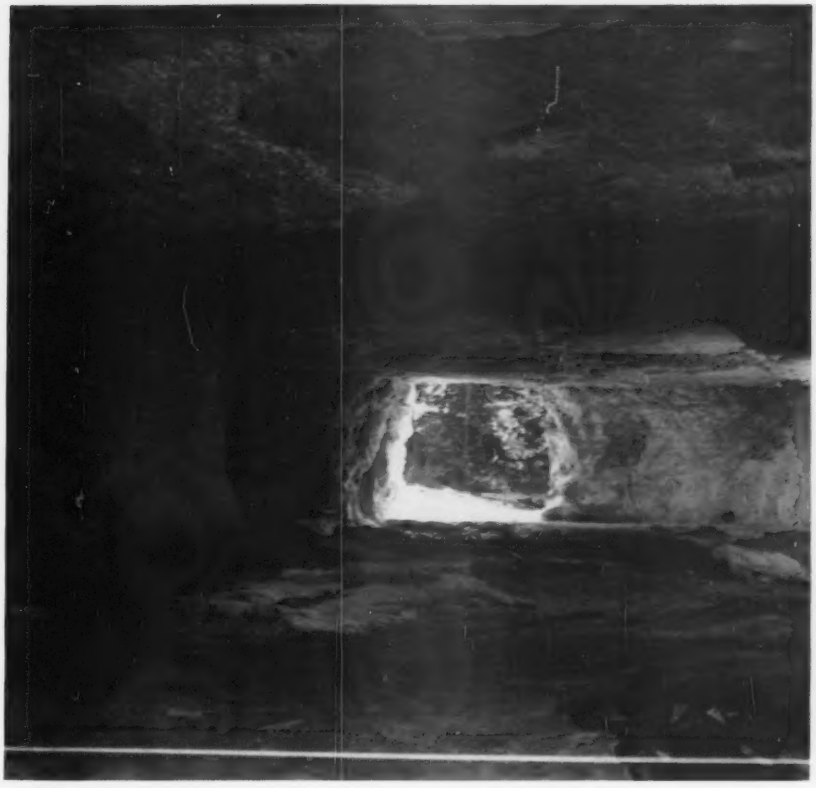
The abandoned area, fed by numerous springs, eventually filled with water. Hidden from the road by the uncontrolled growth of trees and

*Hercules Powder Company
Chicago, Illinois

TUNNEL ENTRANCES: These tunnel entrances were a constant invitation to explore the underground workings of this abandoned limestone mine. Apprehension that someone might be injured while trespassing on the property made officials of the Menke Stone and Lime Company, Quincy, Illinois, decide to seal the entrances to the tunnels.

brush, it soon became known as Hidden Lake. To some, Hidden Lake became a favorite spot for fishing or for a picnic on a warm day; to many youngsters, Hidden Lake was an invitation to experience some of the adventures of Tom Sawyer and Huck Finn by exploring the abandoned workings. To the Menke management, however, Hidden Lake was a situation fraught with danger. While no one had ever been lost or injured while exploring the tunnels, there was the ever-present danger that some day such a catastrophe would happen.

Menke officials decided, in the interest of safety, that the abandoned workings had to be sealed, and various methods of accomplishing the task were considered. One method suggested was to block the tunnel entrances with overburden pushed off the top of the bluff by bulldozers. This idea was given up as being too time-consuming. It was then decided to explore the possibility of using explosives to knock down the supporting pillars. This would allow the overburden to drop down by its own weight into the old workings, thus effectively sealing the mine and eliminating a potential hazard.



INSIDE THE MINE: Here are shown three of the supporting pillars. When these and eight other pillars were removed by dynamite, the overburden collapsed to effectively seal the mine from trespassers bent on exploring the abandoned property.

Explosives Used to Seal Mine

Ed Siebrasse, secretary-treasurer, Superintendent Dallas Kinne, other Menke officials, and representatives of the explosives manufacturer examined the old workings to determine the feasibility of this method. Their survey revealed an area of approximately 200 by 260 ft., with pillars of various sizes and shapes supporting the roof of the mine. Some of the pillars were L-shaped, others nearly square, and one was oblong, measuring 50 by 16 ft. The height of all pillars was about 18 ft. It was the opinion of the survey group that by removing 11 of the supporting pillars the overburden would collapse and seal the mine.

Before underground operations could begin, it was necessary to drain the workings, for Hidden Lake extended well into the abandoned limestone mine. The lake was well stocked with fish; these were netted and removed to nearby fishing spots before draining of the property began. By draining the lake, most of the water was also removed from the mine, although a small amount remained in the area of some pillars, but was not sufficient to cause anything more than a little inconvenience to the drilling and blasting crew.

No two pillars were of the same size or shape and each presented its own particular drilling and loading problem; however, a general pattern, varied to suit each pillar, was designed. The procedure used in blasting pillar No. 6 may be considered as a typical drill round. This pillar was 30 by 15 and 18 ft. high. Three rows of 1¾-in.-diameter holes were drilled in the pillar. The bottom row, 1 ft. above the floor level of the mine, consisted of eight holes all angled downward. The middle row, about 3 ft. off the floor, was of nine holes drilled horizontal to the floor. The top row contained eight holes pointing upward and about 5 ft. from the floor. The center hole of each row was drilled straight in and the remaining holes fanned out to the right and left. The holes in this pillar were 14 ft. deep and spaced approximately 4 ft. apart. The diameter of the holes in the remaining pillars was uniform at 1¾ in., but the depth and spacing varied according to the dimensions of the individual pillars. All drilling was done by a Gardner-Denver drill mounted on a hydraulic boom which, in turn, was mounted on a truck for mobility. Because of the ease afforded in moving from pillar to pillar, this type of drilling equipment made for rapid drilling cycles, and the 415 holes required for the explosives charges in the 11 pillars were drilled in record time.

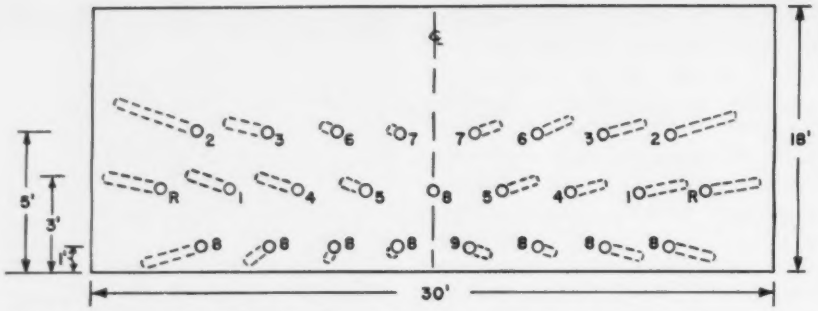
Loading the Explosives

A total of 3,800 lb. of Hercules EP-160-4X and EP-160-5X in 1½ by 16-in. prewaxed cartridges was loaded into the 415 holes. The amount of powder loaded in the holes of the individual pillars varied considerably and was dependent on the depth of the hole. However, each hole was loaded to within 24 in. of the collar, tamped firmly, and then stemmed with 1½ by 12-in. tamping bags filled with lime dust. All charges were primed

with Hercules® Electric Blasting Caps or No Vent® Short-Period Delay Electric Blasting Caps, periods 1 through 9.

To achieve a slabbing action, the explosives charges in the end holes were primed with instantaneous electric blasting caps and delays were used in priming the charges in the remainder of the holes, with the delays firing toward the center of the pillar. With this order of firing, each successive hole was shot toward an open face.

Because of the great number of primers and the large amount (about 3,000 ft.) of 20-gauge Hercules connecting wire required to hook up the shot, the blast was connected in a series-in-parallel circuit containing 12 series. About 360 ft. of No. 12 gauge solid copper leading wire, rubber covered because of the extreme moisture, were needed to bring the firing line to the outside of the tunnels. At this point, 14-gauge duplex cotton-covered lead wire was connected and strung out to the sheltered firing point about 250 ft. distant. A Hercules Titan* Blaster supplied the current for actuating the blast.



DRILLING PATTERN: The drilling round illustrated is typical of those used in removing the supporting pillars. The diameter of all drill holes remained uniform at 1¾ in., but the spacing and depth varied depending on the dimensions of the individual pillars.

Every effort was made to keep the project of sealing off the tunnels a secret until completion of the blast. It was feared that publicity would lure spectators to Hidden Lake and expose them to possible injury while watching the demise of this popular spot. Shortly before firing time, the Illinois State Police set up roadblocks to stop all traffic in the vicinity of the mine. The area was also combed for any spectators who might have wandered into the property.

The blast was a complete success. The pillars were removed exactly as planned and the overburden dropped down to effectively seal the entrances to the tunnels. There was no damage to surrounding property and no injury to personnel on the project.

*Hercules Trademark

AFTER THE BLAST: No longer will the Hidden Lake area hold any attraction for the explorer. The overburden dropped down and sealed off the mine entrances after the supporting pillars had been removed by dynamite.

NEWS NOTES

GOODYEAR V-BELTS

A 16-page, informative booklet entitled "V-belts, the Testing, Inspection, and Control of their Quality" has been issued by the Goodyear Tire and Rubber Co.

Fourth in a series, the new booklet describes in words and with pictures how raw materials and finished belts are tested and inspected. One section of the book explains quality control procedures, another is concerned with experimental production. Readers can get a copy of this booklet by writing Dept. 794, Goodyear Tire and Rubber Co., Akron 16, Ohio.

GEOPHYSICAL ESSAY CONTEST

The annual world-wide geophysical essay contest conducted among college students by the Society of Exploration Geophysicists was recently announced by Dr. Charles W. Oliphant of Tulsa, Oklahoma, chairman of the contest committee. A cash prize of $150 will be awarded the first-place winner, Dr. Oliphant said, with $100 for second and $50 for third prize. To be eligible, the essay must be written by a graduate or undergraduate college student who has had, or is now taking, at least one course in geophysics. It must be concerned with some phase of earth physics. Manuscripts must be received by September 1, 1958. The winner will be announced at the 28th annual international meeting of SEG October 13-16 in San Antonio.

Detailed rules of the contest may be obtained by writing to Dr. Oliphant at 1905 National Bank of Tulsa Building, Tulsa 3, Oklahoma.

LIGHTWEIGHT HYDRAULIC GOVERNOR

A compact, lightweight hydraulic governor of the speed droop, lever type has been announced by Farris Pickering Governor Company, Inc., Palisades Park, N. J. The new unit, Type 4300, is designed for speed control of gasoline or diesel generator sets, engine-driven compressors, engine-driven arc welders, marine engines, trucks, tractors, hoists, bulldozers, and similar equipment.

Type 4300 is usable for variable or constant speed service, using engine lube oil as the pressure medium at a minimum input pressure of 5 psig. The unit provides immediate response to load change and will regulate within ¼-percent steady state operation. Mounting pads, terminal and speed adjusting shafts are interchangeable with present field installations.

Type 4300 weighs only 10½ pounds and has an overall height of 6⅛ inches, yet work capacity is 12-inch-pounds, with an optimum operating speed of 2400 rpm. Complete technical data are available on request from Farris Pickering Governor Company, Inc., 513 Commercial Avenue, Palisades Park, N. J.

BOOKLETS ON SAFETY

The National Safety Council has two new publications available for industry – one for employes, the other for foremen. The publications "Rules for Safety" and Book 8 in a series of "Five-Minute Safety Talks for Foremen" are designed to promote safety in industry.

"Rules for Safety," the Council says, is the "biggest and best safety rules booklet ever compiled – 40 pages covering accident prevention do's and don'ts, how's and why's." The booklet gives safety rules for using power tools, stacking material, and lifting and carrying.

The book of safety talks for foremen is a compilation of talks that appeared in earlier books in the series. The 52 talks in Book 8, the Council says, "provide full and balanced coverage of all the major types of occupational accidents."

Talks in Book 8 range from "Why We Have a Safety Program" to "Bumping into People and Things."

Free copies of descriptive brochures on the literature are available from the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

NEW KOEHRING CATALOG

A 24-page catalog just released by Koehring Company contains 11 on-the-job and 46 assembly photos of the Koehring 1205 excavator. Printed in two colors, the catalog has a special section devoted to the 1205 carbody and lower machinery. Included in the section are an explanation and photos of the six turntable and six hook rollers used to maintain operating stability under any digging or lifting strain. Schematic drawings trace the power flow through the turntable and carbody. Additional sections deal with positive traction steering, split lagging for quick convertibility and exclusive 4-ft. "feel of the load" power clutches.

Capacities listed in the catalog for the 1205 are: 3 cu. yd. as a shovel (including the High Lift model equipped with 40-ft. boom and 29-ft. stick for strip mining), 3 to 4 cu. yd. as a dragline and 95 tons as a crane. A weight chart, important to 1205 owners who must transport their machines, plus a diagram showing disassembly, are included.

Copies of the catalog can be obtained by writing to Koehring Company, 3026 W. Concordia Ave., Milwaukee 16, Wis.

READY-MIX CONCRETE TRUCK INFORMATION

The White Motor Company has just issued a new folder containing factual data on truck applications for ready-mix concrete service. The folder contains engineering data showing features to look for in the selection of a truck for service in the ready-mix industry. It includes information on proper power take-off application, and describes engineering features and quality construction used in the White 9000 chassis, ideally suited for this service. For a copy of this folder write to Sales Promotion Department, The White Motor Company, Cleveland 1, Ohio.

NEW 70-TON P & H TRUCK CRANE

Combining heavy-duty capacity with a 200-foot lift and a high degree of mobility, the all-new 70-ton P & H 775-TC announced by Harnischfeger Corporation features Magnetorque swing, the exclusive P & H frictionless clutch mechanism for safer, smoother swing motion. Direct-action hydraulic controls assure accurate spotting of 70 tons at a 15-foot radius. Removable front and rear outriggers and counterweights provide maximum weight reduction for fast job-to-job moves.

Designed to meet the needs of the construction industry for greater lifting ability, higher working and travel speeds, and increased safety and accuracy, this new truck crane was specifically engineered for dependable operation on today's vital bridge and multi-story building construction, according to the manufacturer.

The new 70-ton unit is either gasoline or diesel powered and mounted on an 8-wheel, 4-wheel drive, P & H diesel-powered crane carrier designed to rigid P & H specifications.

For more information write to Harnischfeger Corporation, Wilwaukee 46, Wis.

NEW I-R DUSTLESS STOPER

Ingersoll-Rand has developed a new rock drill known as the "Vacujet" dustless stoper which sucks all dust and cuttings down through the drill, then discharges them under pressure through a long hose to a container.

The new stoper, described in Ingersoll-Rand's flier Form 4195, works like this: vacuum is developed by an ejector jet incorporated into the backhead of the drill. This vacuum draws the cuttings down through the drill steel and the drill. When the dust and cuttings reach the jet, they are caught in the jet air stream and pushed under pressure through a hose to a tank or bag 25 feet or more away from the drill.

The manufacturer stresses that the stoper is a completely new drill and not merely a modification.

You may learn more about the new stoper by writing your nearest Ingersoll-Rand branch office for the flier, or by contacting Ingersoll-Rand, 11 Broadway, New York 4, New York.

PRESSURE REGULATORS BULLETIN

A new 28-page bulletin, "Pressure Regulators . . . and How To Select Them," has been issued by Kieley & Mueller, Inc., control valve manufacturers, of Middletown, New York.

Of special interest is a ten-page prefatory section which explicitly spells out the most important considerations for correct application of self-operating and pilot-type pressure regulators. Included are a number of graphic tables that permit the reader to make rapid comparisons of basic regulator characteristics without reference to detailed specifications given elsewhere in the booklet.

The bulletin covers back-pressure and relief valves of spring-loaded and weight-loaded types; reducing valves; remote pilot-type and valve-mounted regulators; pump governors; steam-operated, packless, self-contained, and differential regulators. Catalog information has been carefully organized for each item; a consistent format for specification data simplifies selection.

Copies of the bulletin may be secured by writing Kieley & Mueller, Inc., 64 Genung Street, Middletown, New York. Request Bulletin No. 401.

SCHRAMM ANNOUNCES "ROTATOOL"

A whole new concept of drilling is opened with the Schramm Rotatool, a percussion tool that does its work at the bottom of the hole. According to the manufacturer, the Rotatool makes possible fast, economical drilling in hard rock formations that stop ordinary rotary drills, permitting operation in locations where cost factors formerly prevented profitable production.

The new tool has only three moving parts and its rugged construction indicates long life and low cost of maintenance.

Rotatool is available in two models. No. 3875 takes a 4½-in. bit and requires 100 cfm of air at 100 psi to operate. The larger size, No. 5250, takes 6-in. and 6½-in. bits and requires 350 cfm of air to operate. Principal fields of use for the Rotatool are large cut-and-fill operations in construction work, blast hole work in quarries, water well drilling, strip mining, submarine work (river crossings and channel deepening), and military applications.

Further information is available from Schramm, Inc., 900 East Virginia Avenue, West Chester, Pennsylvania. Send for Bulletin DH-58.

NIAGARA POWER

(Continued from page 42)

is 563 ft. mean sea level. The normal elevation of Lake Ontario into which the river runs is 248 ft. and the tailwater below Lewiston is approximately 1 ft. high. Therefore, the gross head developed will be about 314 ft., and, allowing 5 ft. for head loss in the waterways, the average net head will be about 309 ft.

The generating station will be of the outdoor type, of reinforced-concrete construction, and designed to house thirteen 150,000-kw. units. The generators will be driven by vertical, Francis-type turbines rated 200,000 hp. at best efficiency and 300-ft. head.

The step-up transformers will be located at the generating station deck level directly behind the powerhouse and connected by high-tension lines to the switchyard.

Hydraulic Turbines—Lewiston Powerhouse

The adopted size of turbine represents the manufacturer's recommendation for the largest diameter runner that may be furnished and shipped in one piece for a 300-ft. head development. The turbines will each have a full-gate capacity of 235,000 hp. at 300-ft. net head. They will have conventional plate-steel spiral castings and concrete elbow-type draft tubes. The centerline of the distributor will be located at elevation 250 which places the bottom of runner at elevation 245 (2 ft. below the level of minimum tailwater) so as to provide adequate insurance against cavitation when the turbine delivers 235,000 hp. with tailwater at elevation 250.

The main power transformers for the Lewiston powerhouse are located on the inshore section of the generator-operating deck at elevation 302. The installation will comprise 13 forced oil- water-cooled transformers, 180,000 KVA, 13.8/230 and 13.8/115 kv. Lightning arrestors are mounted on the power station concrete directly in the rear of the transformers.

The main leads between the generators and the transformers will have factory-fabricated bus and housing. The lines from the transformers to the switchyard will be 115 kv. and 230 kv. high pressure oil-pipe-type cable.

A switchyard will be constructed adjacent to the open canal, located on flat ground in the area between the pump-generating plant and Niagara University grounds.

The Niagara Parkway to be constructed along the river front, a distance of four miles, will extend from the North Grand Island Bridge to the Rainbow Bridge. It will be constructed of surplus material from the excavation required during the cut-and-cover conduit construction and open-canal construction.

VIBRATION EFFECTS
ON
STRUCTURES • WELLS
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Seismograph . . . Accelerograph
Electronic Comparascope
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Investigation of Explosions and Explosives Accidents

There's A Size and Type of
ABC POWDER BAG
for every
Mining and Quarrying Need!

Constructed of tough rubberized jute fabric for long wear. Amply reinforced, well-balanced, easy to carry. Keeps explosives dry. Makes blasting safer. 20 to 60 stick pouch type bags—125 to 160 stick knapsack type. Special 160 stick Neolon (neoprene coated nylon) bag Model 333NS developed specially to resist extreme corrosive conditions found in some mines.

The NEW "LONGSTICK" BAG

Model 360, pouch type bag, developed to carry the new long length sticks of explosives, used in some mines and quarries. ABC bags made to your requirements.

Send for Bulletin 556 AND PRICES.

AMERICAN BRATTICE CLOTH CORP.
270 S. Buffalo St., Warsaw, Indiana

VIBRATION TROUBLES?

EXPLOSIVES USERS — If you are experiencing or anticipate legal or public relations problems arising from blasting effects—

Send For Our BROCHURE Describing Our Services
(Price Schedule Accompanies Brochure)

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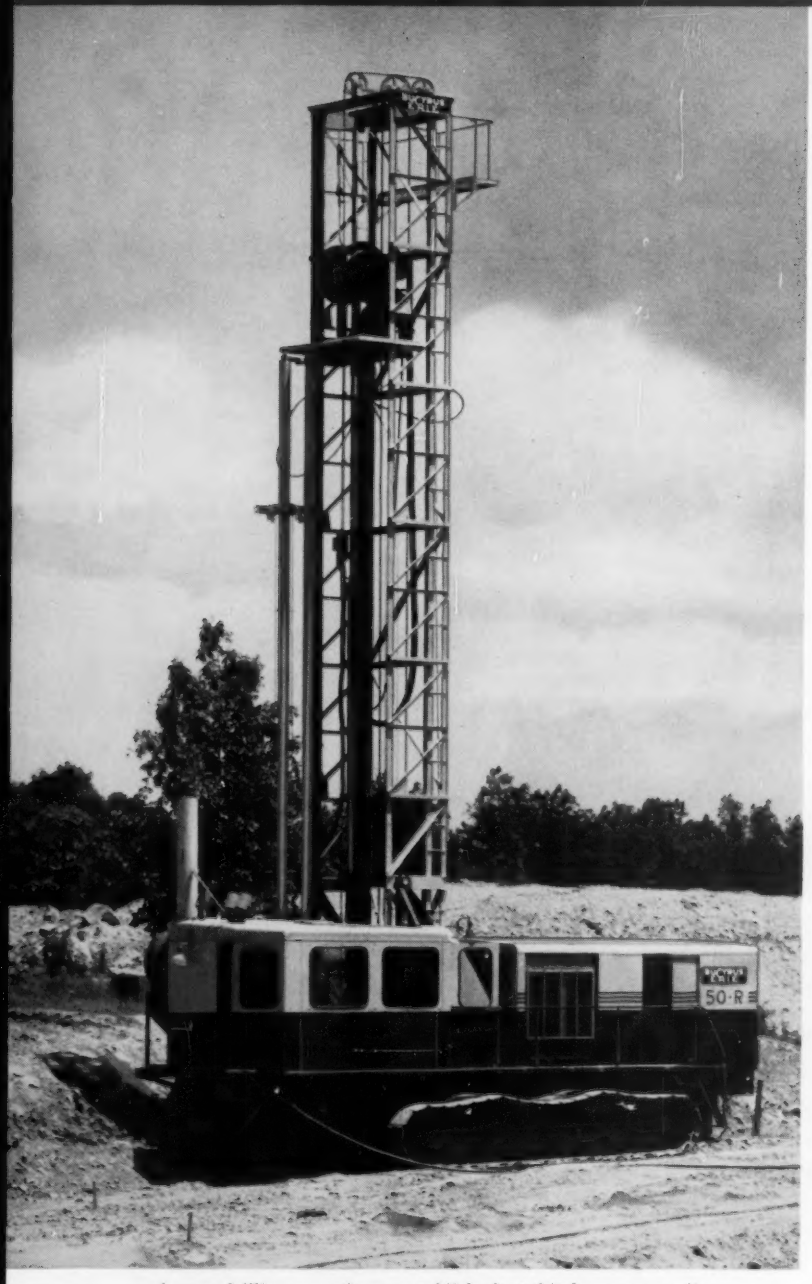
THE VIBRATION ENGINEERING COMPANY
301 Hazleton National Bank Bldg. • Phone: GLadstone 5-1961 • Hazleton, Pa.

Pittsburgh Area Office
Philip R. Berger, Mgr.
Bradford Road
Bradfordwoods, Pa.
Phone: WEstmore 5-1655

B. F. Howell, Jr., Ph.D., P.E.
Chief Seismologist

Affiliated with
Frank Neumann, Seismologist
4546 45th Ave., N.E.
Seattle 5, Wash.
Phone: Lakeview 4-0028

BUCYRUS-ERIE ROTARIES Speed Blast Hole Drilling



A new drilling record was established at this large open pit coal mine in Indiana when the 50-R shown here was put into operation.

BUCYRUS-ERIE rotaries are increasing drilling footage at open pit mines everywhere. Their ability to put down hole fast results from an exclusive combination of features — variable drilling speed and variable down pressure.

For controlled speed, the Ward Leonard variable voltage system gives the operator smooth, instant command over rotation of the drill pipe. He can choose the most efficient speed for a given formation. To meet requirements, he can vary the speed without stopping the drilling operation.

In hard formations, maximum down pressure can be exerted on the bit while the drill pipe is turning slowly. This gives greatest possible penetration.

In soft formations, the operator can increase rotating speed substantially as he cuts down pressure. He can match pulldown force and rotation speed so tools do not advance faster than cuttings are removed. At the same time he keeps up enough air velocity to remove cuttings from the hole.

For the full story on Bucyrus-Erie rotaries, contact Bucyrus-Erie Company, South Milwaukee, Wis. Ask for illustrated bulletins on the 50-R (full-electric rig for drilling 9⅞ to 12¼-in. holes) and the 40-R (diesel or electric rig for drilling 6¾ to 9-in. holes).

82858C

BUCYRUS ERIE

A Familiar Sign at Scenes of Progress

BUCYRUS-ERIE COMPANY • SOUTH MILWAUKEE, WISCONSIN

If You Use Blasting Caps

EXAMINE THESE FEATURES

1. **DEPENDABLE FIRE**—Special alloy is used as the bridge wire in the firing element of Hercules Electric Blasting Caps. Wire is noncorrosive.

2. **ENGINEERED SHELL**—Bronze shell of a Hercules cap goes through fifteen separate operations while it is being expertly shaped.

3. **TOUGH, HIGH DIELECTRIC INSULATION**—Leg wires of Hercules caps are coated with plastic insulation for outstanding toughness, resistance to abrasion, superior dielectric qualities.

4. **SECURELY ANCHORED**—A cast sulfur plug in the upper part of shell anchors entire firing mechanism in place.

5. **WATERTIGHT WATERPROOFING**—A special Hercules waterproofing formulation minimizes the possibility of moisture or dampness penetration.

6. **DOUBLE-PACKED WALLOP**—Bridge wire extends into the priming charge and makes positive contact to give rapid ignition.

7. **DOUBLE-PACKED WALLOP**—Bridge wire extends into the priming charge and makes positive contact to give rapid ignition.

HERCULES® **BLASTING CAPS**

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New York, Pittsburgh, Salt Lake City, San Francisco

XR58-1

2400 cfm of GYRO-FLO air power speeds pipeline through Kentucky hills

The hills of Kentucky are fine for scenic beauty, but they're rough on pipeline construction. Rough terrain, hard Kentucky limestone, and completely desolate—remote from service and repair facilities.

The photo above shows how the Bechtel Corporation, Pipeline Division, surmounted these difficulties in laying the Tennessee Gas Transmission Company's 30" loop line from its Morehead pumping station to its station at Load, Ky. Four boom cats, each pulling its own 600-cfm Gyro-Flo portable compressor, work in series, drilling eight blast holes simultaneously at each move. Here Gyro-Flo's proved *dependability* and virtual freedom from maintenance were important factors in keeping up to schedule, for down-time on any unit would have seriously slowed the job.

Available in 6 sizes, from 85 to 900 cfm, the Ingersoll-Rand Gyro-Flo compressor is the ideal portable for pipeline work, where trouble-free performance pays big dividends. Don't go slow—go Gyro-Flo!

Ingersoll-Rand

2-726 11 Broadway, New York 4, N.Y.

THERE'S ONLY ONE GYRO-FLO . . . INGERSOLL-RAND'S ROTARY PORTABLE COMPRESSOR

But the best idea is to use *Quarrycord* for one shot lighting of secondary blasts

Prime with safety fuse and blasting caps. You'll play-it-safe two ways:

- No danger from stray electrical currents or thunderstorms.
- No big "boom!": you get a series of small shots: "pop-pop-pop".

Connect and ignite your safety fuse primers with Quarrycord and play-it-safe *again* because—

- No men on the rock pile. The entire blast is set off by *one* man at a point where escape is safe and easy.

Quarrycord is packed on spools in 100-ft. lengths. It is easily lighted with a match and burns with a very hot open flame at the rate of about one foot per second.

HOW TO USE QUARRYCORD

Cut your safety fuse in equal lengths as prescribed by your State law, and prepare your primer cartridges. On the end of the fuse opposite the blasting cap place a Connector. This is a metal tube containing an ignition compound in the slotted end, and color-banded for easy identification. Load and tamp the holes.

When ready to blast, connect all holes with Quarrycord, placing it in the slot of each Connector and pressing the "lid" down to hold the Quarrycord firmly in place and assist ignition.

Connect your main lines with cross lines wherever these will cut down the over-all burning time. Lead main lines off to a point away from the rock pile. When all is ready, light this end with a match and go to a place of safety.

Q-8

It's quite a story, told completely in this folder which we'll send you, free, when you ask for it. Write today.

Your explosives supplier can supply Quarrycord and Connectors.

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Simsbury, Connecticut • Since 1836

Primacord® and Detacord® Detonating Fuse, Safety Fuse, Ignitacord®, Quarrycord®, Pyrotechnical Devices and Blasting Accessories

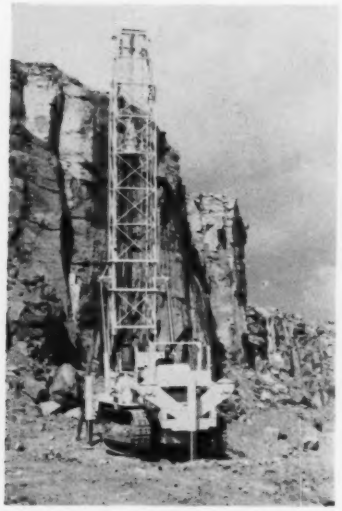
for lower cost blasting and removal operations

Final costs in blasting and removal operations are, to a great extent, determined by the efficiency of the blast hole equipment. Hole production must be fast; moving time held to a minimum. Blast holes must be correctly spaced, of the right size and to a depth that gives clean cleavage, adequate fragmentation for fast loading and easy handling in removal operations.

PORTADRILL Rotary Drills are engineered and built to cut costs. The unitized construction eliminates auxiliary equipment, reduces servicing and maintenance costs. One or two man operation saves manpower. Optional tractor or truck mounting assures the mobility and maneuverability necessary for precise spacing and minimum time in moving from hole to hole. Patented safety devices; full hydraulic operation including mast control; water-fog dust and cuttings control and other features contribute to faster hole completion and lower costs.

PORTADRILL's initial cost is lower! Its production matches or exceeds like-rated drills. Its heavy duty construction assures longer life under any operating condition.

Our world-wide sales and field engineering service stands ready to aid in solving your blast hole problems in mining, quarrying and construction. Inquiries concerning specific applications are invited.



PORTADRILL MODEL 105TA

Self-propelled, self powered rotary drill for 5⅝" to 9" blast holes. Uses standard roller cone rock bits or rotary-percussion tools. Up to 50 PSI and 1,000 CFM available for cuttings removal. Prime mover is optional — shown here is the Eimco 105 Diesel Tractor.

PORTADRILL MODEL 10TC

A versatile 3-way drill equipped with mud pump for "wet" drilling and dual compressors for "air" drilling or for use with rotary-percussion down-the-hole tools. Unit mounted diesel engine powered. Rated capacity of 9" diameter holes. Optional mountings available.

PORTADRILL®

Mfg. by The WINTER-WEISS CO. 2201 Blake St., Denver 5, Colo., USA

Portadrills are available for vertical hole operations to 2,000' depths and up to 60" diameter holes. Complete details on request.

PORTADRILL MODEL 6TA

Portadrill Model 6TA, owned by the Strong Co., Springville, Utah, starts the Glen Canyon project. Mounted on a Caterpillar D8 Tractor with integral compressed air system for cuttings removal, this 6TA averaged 300' of 6¼" hole per shift in sandstone ranging from medium to granite hardness. Pattern was 15x15 to 17x18 square grids. Roller cone rock bits gave up to 3,600' production. Powder charges of 0.6 lbs. per cu. yd. broke the sandstone for handling by scrapers. Solid rock is profitably moved at a contract price of $1.10 cu. yd.

IMPOSSIBLE WITHOUT EXPLOSIVES

To break down coal seams interspersed with thick bands of heavy rock and slate, a strong, dense grade of permissible powder is needed to get economical results from blasts.

Hercules manufactures such a permissible powder, along with other grades and strengths of explosives to meet the many and varied conditions in coal mines throughout the nation.

Our technical sales-service representatives welcome the opportunity to discuss with you Hercules permissible powders in "King-Size" cartridges, and to show how their use results in improved methods of blasting and more efficient operation of your coal mine.

KR57-3

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